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Teaching Fact Fluency through Focused Strategies

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An Action Research Report

By Kelly Jahn & Joan Selle

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Advisor: _____ Date: _____

Abstract

The action research study was conducted in two third grade classrooms in North Dakota. There were 23 students in one class and 20 in the other. All but one student was Caucasian, and all were middle to upper class. This study was conducted to focus on the rate of improvement of fact fluency through focused strategies. Pre-assessment data were collected in the form of surveys and baseline assessments given to students. Students were surveyed on feelings toward mathematics, addition, and fact fluency. Students were also given a baseline assessment to demonstrate prior abilities before the intervention. After pre-assessment data were gathered, students were divided into focused groups and rotated through daily mathematic stations. One class was given daily elapsed time tests and the other class was given daily timed tests. At the completion of the six-week intervention period, students were reassessed to determine growth since the baseline assessment. Results indicated that students did become more fluent in addition facts; however, more time was needed to reach automaticity.

"Fluency refers to the ease and accuracy with which a skill is carried out" (Locuniak & Jordan, 2008, p 451). Mathematics is a combination of computational skills and strategic problem solving "Weak consolidation of number facts reduces cognitive and attentional resources that are necessary for higher level problem solving" (Locuniak & Jordan, 2008, p 451). It is vital that students can successfully compute basic mathematic facts in order to solve complex problems (Suydam & Dessart, 1980, as cited in Goldman, Mertz, & Pellegrino, 1989). "Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they perform a range of complex tasks" (Woodward, 2006, p. 269). To ensure success in mathematics, students must have math fact fluency skills. Math fact fluency is the ability to quickly recall accurate answers to single digit computations. Fact fluency is a part of the foundational building blocks of mathematical education. Without this skill, students have a hard time comprehending higher-level math problems. Automaticity is a valuable tool that is used not only in the classroom, but also in real life situations. Students need these basic fundamental skills so that when they do move on to higher-level mathematics they will have the capacity to solve more complex problems. Students who spend less time recalling simple math facts are more likely to engage in advanced math tasks which will in turn help further develop skills and ability (Miller, K. C., Skinner, C. H., Gibby, L., Galyon, C. E., & Meadows-Allen, S., 2011). When students know and understand basic math facts, their ability to perform mental math and higher level thinking in mathematics increases because there is no need to focus on simple computations (Locuniak & Jordan, 2008; Sun & Zhang, 2001). Learning to solve simple equations using automatic recall is a

complex process (Hopkins & Lawson, 2002). Therefore, when teaching fact fluency it is important to consider many strategies to help construct this foundational skill.

Fact fluency is a vital skill for all students to ensure that they will find success in mathematics. Many studies have focused on the different ways to teach automaticity of facts; however, there has not been one specific method that stands above the rest. It has been found that a combination of strategy along with drill and practice will yield the best results. This combination will help students become more successful in the area of fact fluency.

In the schools we teach, we have noticed that students in intermediate grade levels are lacking the fact fluency skills needed to solve higher-level mathematics problems. To make up for the lack of student knowledge, teachers have had to spend extra time backtracking to reteach these skills and cannot focus on to grade level material until foundational skills are formed. Formative and summative assessments also show that students are not proficient in fact fluency. These problems could be partially due to our current mathematics curriculum, lack of focus on memorization skills and strategies, and student motivation. Teachers need to research materials from other sources to make up for lacking areas in our curriculum and accommodate to Common Core Standards. In previous years, students have not been required to memorize skills, instead they were taught multiple strategies to compute simple math problems to ensure they have the skills to solve a variety of problems. We have also noticed that motivation to learn facts is not a main priority. Students do not take flashcards home to practice and do not take responsibility for their own learning. We have decided to implement focused math strategies to improve addition fact fluency in our third grade learners.

Students from two different third grade classrooms will participate in a fact fluency research project. Kelly's classroom is located in western, North Dakota, the second, Joan's classroom is in central, North Dakota. In Kelly's classroom, there are 23 students, 8 boys and 15 girls. One student is African American all other students are Caucasian. Students range from middle to upper class on the socio economic scale. These students have a variety of learning needs. Three students are currently on math IEPs. According to 2013 mathematics NWEA test scores, 34% of these students are performing at grade level or higher, and 66% are below grade level. Joan's classroom contains 20 students, 10 boys and 10 girls. All students are Caucasian and are also middle to upper class. Two students have learning disabilities, but only one is on a math IEP. One student has an emotional disorder, however academic learning is not affected. According to 2013, mathematics NWEA test scores, 70% are performing at grade level or higher, 15% are below grade level, and 15% did not take the spring, math NWEA test.

In the past few years, the importance of fact fluency was not stressed at the schools where we are employed. To enhance student fact fluency skills, a study will be done in the previously stated classrooms focusing on this question: How does the rate of improvement in math facts change in a third grade classroom, after implementing addition strategies and drill and practice? It is our hope that through focused strategies and daily practice, students will make gains in our six-week study and improve addition fact fluency. In the next section, the research process is described and how we implemented our six-week addition fact fluency intervention.

Description of Research Process

In the six-week intervention period, data were collected in the form of surveys, baselines, elapsed time tests, timed tests, and a summative test. At the beginning of our study, which was the first week of school, all students were given a survey to explain how well they know their math facts and to list strategies they currently use. Then students were given a baseline to show their ability. This assessment included forty addition problems. Students were given two minutes to complete as many problems as they could. Both instructors analyzed the data and set up different procedures in their own classrooms to fit the needs of their students for this study.

Students from Kelly's classroom where split into four groups based on results from the pre assessment. Every morning when students arrived at school, students would go to their math fact station. The stations included: Small strategy group with instructor, Cover, Copy, Compare (CCC), listening track, and flash cards. Students would rotate to a different station each day, and would work at these stations for 10-15 minutes.

Cover, Copy, Compare, is an independent activity that gives students instant feedback. A student looks at an already completed math fact 6+3=9; they cover the problem, and copy it onto paper. This process is continued with different math facts for the remainder of the rotation.

Listening track is another independent activity that gives students instant feedback. A group of students listen to a CD that repeats math fact problems. Students write the answer down and then listen to the correct answer. Example: CD would say 6+2=_____, student would write down the answer and wait for the recording to tell the

answer. If the student wrote the incorrect answer, they would then copy down the correct answer, and wait for the next problem.

The flash card station allows students to work with a partner. One partner flashes a card to the other partner and says the math fact problem. The other partner then must repeat the problem with the correct answer. Partners switch roles and repeat this for the remainder of the time.

Small strategy group instruction is an activity that allows students to interact with the instructor. It also gives the instructor time to observe students and the strategies they are using. Some of the teaching points used in this strategy groups are: combination of numbers that make 10, touch points, counting on, doubles, and like doubles.

After the 10-15 minutes of rotations, students would then go back to their desks and prepare for an addition elapsed time test. Elapsed timed tests were numbered, and students would start from the beginning. The first test was adding 1 to single digit numbers. (Example: 5+1=____, 7+1=_____) All students would take the test at the same time, then write down their completion time or the amount of time it took for them to complete the test, on their page and graph their times. Tests and graphs were then collected and graded before being returned back to students. This time would be their initial score for that test. The next day, students will take the same test and try to beat that completion time, and still have all correct answers. Once students have answered all the problems correctly on the test and have exceeded their initial completion time, they will move on to the next test. After +1's, students will move on to +2's, then +3's, all the way through +10's.

Students from Joan's classroom were split into four groups according to ability recorded from the pretest given at the beginning of the year. These four groups would rotate through four different rotations each day: Fastt Math on the computer, flashcards with a partner, seatwork, and small group instruction.

Fastt Math is an online program adopted by the school district to enhance fact fluency. This was the first year it was being used at the third grade level. Students log in to their own account and go through focus facts for the lesson. They see the problem and then they have to type the problems. After they review the focus facts, they begin the typing lesson. Focused problems, without the answers, are given to the students on the screen; students then have to correctly answer the problem in less than three seconds. If they do not correctly answer the problem in less than three seconds, the answer is given, and students have to type the answer. After each lesson, students play a game, which also gives students the focused facts to be answered in less than three seconds, but this time it is presented in a game format. Students complete one lesson and one game each day.

Flashcards with a partner allows students to focus on the facts they are struggling with on the timed tests. Each student pairs up with another student and goes through flashcards once and then they will review the cards that they answered incorrectly or that they could not answer in less than three seconds.

When students are doing seatwork, they are at their desks working independently on math facts that they already know and ones they are trying to master. Students are given a worksheet to do at this time and if it is completed before the rotation is up, they

will practice writing single digit addition problems with the answers in their math notebooks.

Small group instruction is a time for the instructor to meet with students and focus on the needs of the individual students and the group. Different strategies are discussed and the instructor is able to observe how students are able to come up with an answer. This is a time to check in with each student and challenge them at their own levels.

Each day, students from the Joan's classroom took an addition-timed test. All students started on the +1's test, adding 1 to a single digit number. Students were given 20 problems to answer in less than a minute. If a student were able to correctly answer all 20 problems correctly in less than a minute, he or she would move on to +2's. Students will retake the same test each day until they have completed the test with 100% accuracy.

Students tracked their progress on a chart to show progress and these charts were displayed in the classroom. Students were able to compare their progress to the other students in the classroom.

To end the study all students were given a post assessment that included the same forty addition problems as the pre-assessment and again had two minutes to answer as many problems on the page as possible. Students also took the same survey from the beginning of the study to see if feelings toward fact fluency and fact fluency strategies had changed. Data were then analyzed to determine whether students have shown growth over the six-week period and if the explained focused strategies aided students in becoming more fluent in addition facts. In the next section, we analyze our data and

focus on our research question, "How will the implementation of focused strategy program improve addition fact fluency for third grade learners?"

Analysis of Data

A variety of data was gathered during our action research project. First, we scored the pretest that was given to all students at the beginning of the school year. This was used as a baseline, and was referred to at the end once all data was collected to show student growth. Our second form of data was our addition timed tests (Joan's class) and elapsed timed tests (Kelly's class). Both students and teachers tracked student progress. Students graphed their individual progress on student-made graphs. We also kept data on our daily math groups and rotations, and in Bismarck data was taken from the Fastt Math program.

All students in Joan's classroom showed growth from the pretest to the post-test. Growth from the beginning of the year to the post-test ranged from one more correct answer on the test to twenty-three more correct answers on the test. Students who made the most progress were students in the lower range at the beginning of the year, since they had more potential growth compared to students who initially scored high. Students J, L, and Q, who are all under 35 questions answered correctly are currently on an Individualized Education Plan or are in the intervention phase and working toward an IEP.

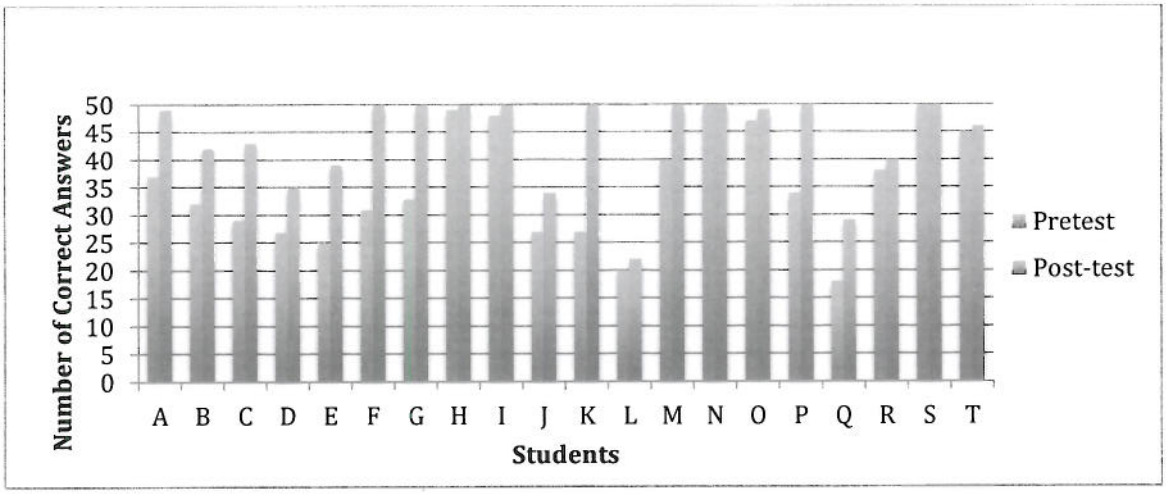

Figure 1. Pretest-Postest Growth (Joan's classroom).

The pretest and post-test were the exact same test. The test was front-to-back consisting of single digit problems 0-5 on the front page and 6-10 on the back page. Students were advised to start with the 0-5 problems are typically easier for students. When the front page was completed, students then moved on to the back page while time continued. Students were given two and a half minutes to complete the page (3 seconds per problem.) In the beginning of the year, two out of twenty students successfully answered all fifty problems correctly in the time allotted. After the completion of the study, nine (including the initial two students) out of twenty students successfully answered all fifty problems correcly in the time allotted. All students improved his or her scores by at least one point (see Figure 2 for overall growth and comparison).

To help prepare students for the post-test, students took daily timed tests to practice their facts. All students started on the 1's test. This test consisted of 20 problems adding single digit numbers plus 1 (Example: 4+1=_____, 9+1=_____). Students could only move on to the next test when the current test was mastered, or all

problems were answered with 100% accuracy within the time limit (three seconds per problem or one minute for the entire test.)

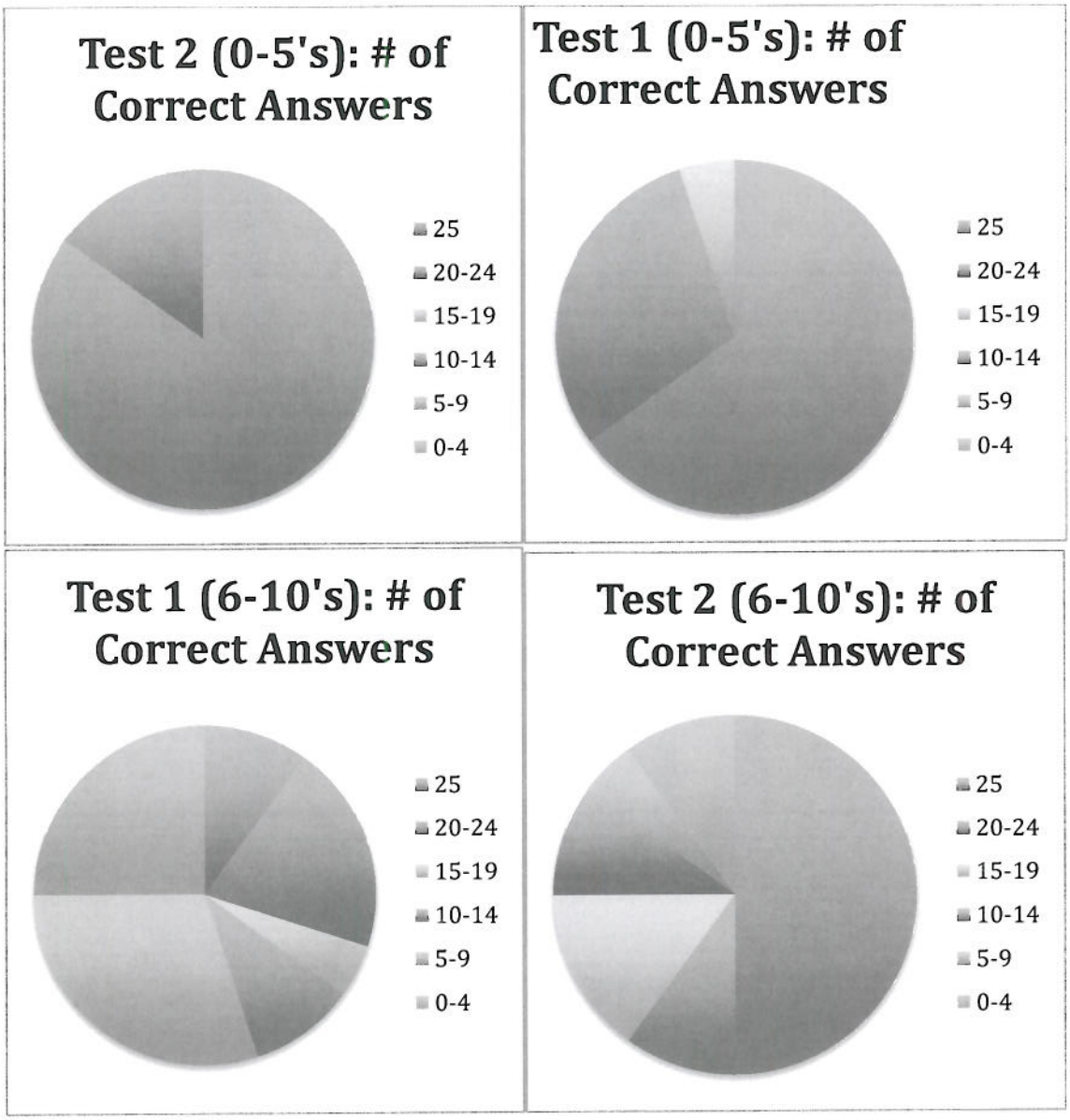

Figure 2. Student Growth from Pretest to Posttest (Joan's classroom).

These tests were given to students on a daily basis. At the end of the six week study, five out of twenty students successfully passed all eleven tests with 100% accuracy. These students moved on to subtraction timed tests with the same rules as the

addition timed tests. Students who did not complete all eleven tests stayed on their current test and will continue to work on their focus facts until mastery is reached (see Figure 3).

In Kelly's classroom, students were given 40 problems of mixed addition facts that ranged from 1-10. These students were given two minutes to correctly complete as many problems as they could. After students were given the pre-test, results showed that students ranged in numerous abilites. Observation from this time test showed a variety of strategies that students were using and not using. Some students were using their fingers to count, some where doing touch points, some knew their facts, and some had no idea what to do. Students were then split into strategy groups and then taught strategies to help them solve additon problems.

During daily timed test students were observed to see if they were using the strategies being taught. Students who were trying the new strategies were increasing their fluency. Students who were not using strategies were given more practice and support to help themfind a strategy that worked. For example, two students were adding 5+4 by counting 1,2,3,4,5 +6,7,8,9= 9. These students worked on counting up from bigger numbers. They decreased their daily test time by 30-45 seconds. Students were also taught ways to solve the problems mentally by finding combinations of tens and looking at doubles.

Over all the majority of students from Kelly's classroom improved their initial score of completed math facts (see Figure 4). Students who completed fewer problems on

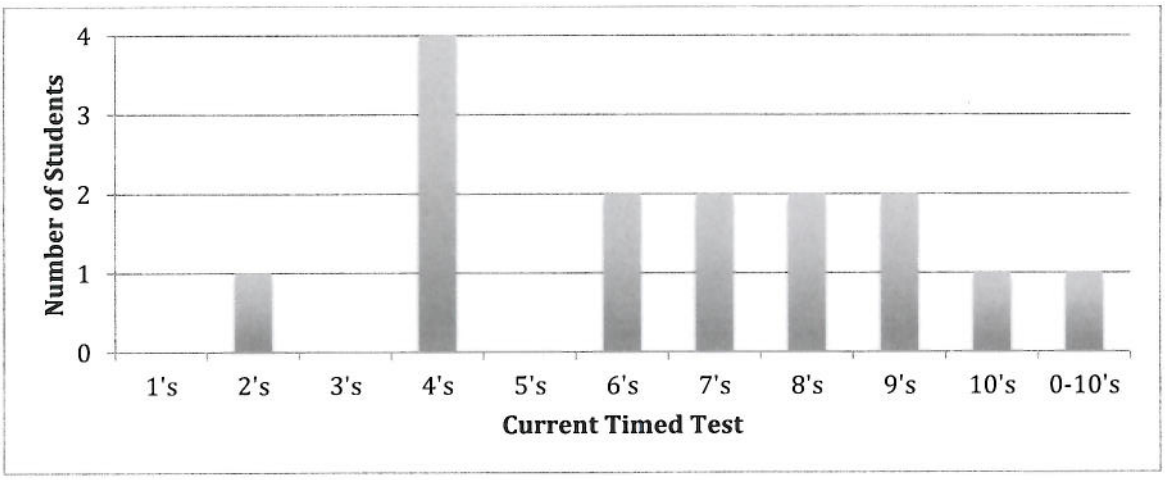

Figure 3. Individual Student Status (Joan's classroom).

their pre-test made bigger gains on their post test compared to those who initially did well.

While some students were learning strategies in small strategic groups other students where working on activites that would help with automoticity. These activites gave instant feed back. These activities were a listening station, CCC, and flash cards. These activites helped students momorize their facts and practice strategies. The affects of giving students time to practice the strategies that they were learning had a positive impact on how many problems students could do in two minutes (see Figure 4). Students were also given a survey to see how they felt about practicing math facts and how confident they were in their own ability (see Figure 5). Students at the beginning of the year showed that they were not really sure how they felt about math facts, and they didn't feel that they were always successful. When students began to take part in the intervention, their behavior showed that they were nervous and very anxious. Toward the end of the intervention, students were had fun trying to beat their time and enjoyed being able to answer math questions easily. The majority of students' opinions and confidence improved during this time.

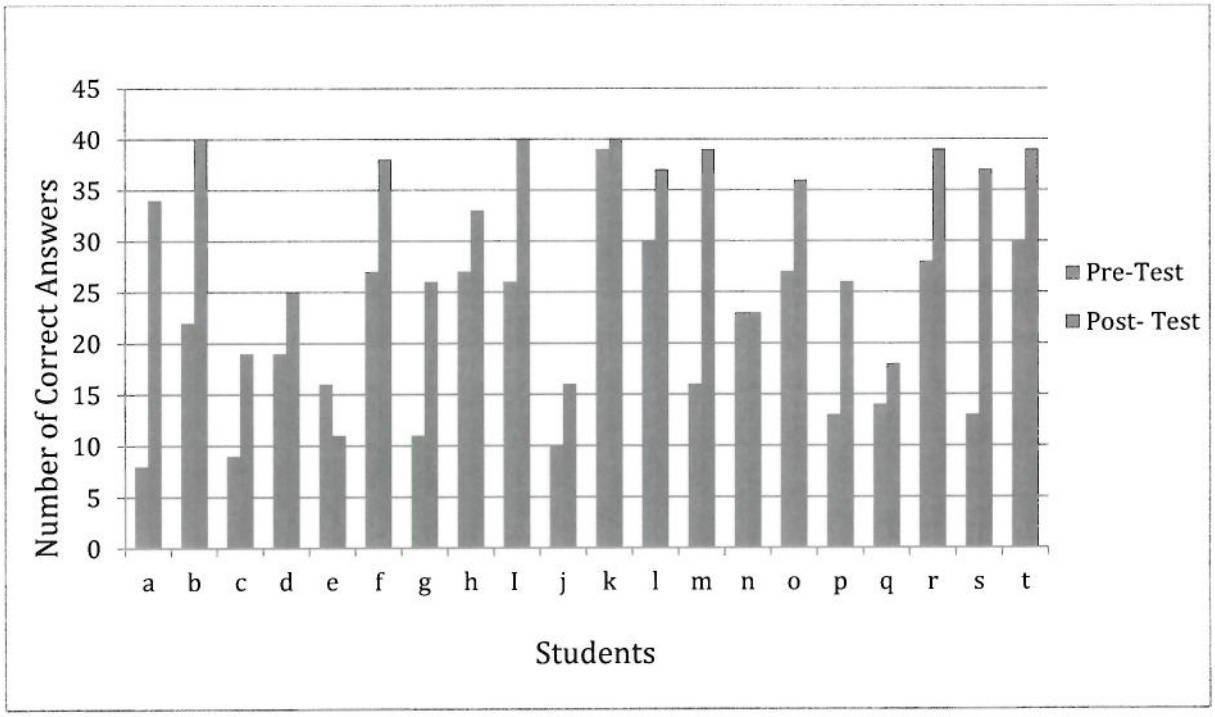

Figure 4. Individual Student Growth (Kelly's classroom).

At the conclusion of the study, Joan felt that her classroom had shown growth through the use of small group rotations, Fastt Math, and addition timed tests, however she felt that the short six week study was not long enough for students to reach maximum potential. Kelly felt that six weeks was sufficient amount of time for her study since her students were able to complete all of the addition elapsed time tests in the six-week period. However, we both felt that students had not yet reached automaticity. Students learned to use strategies more quickly, which in turned lead to students answering problems correctly and more quickly. However students were continuing to use fingers to count, the counting on strategy, and many other strategies that were taught in the six-week period.

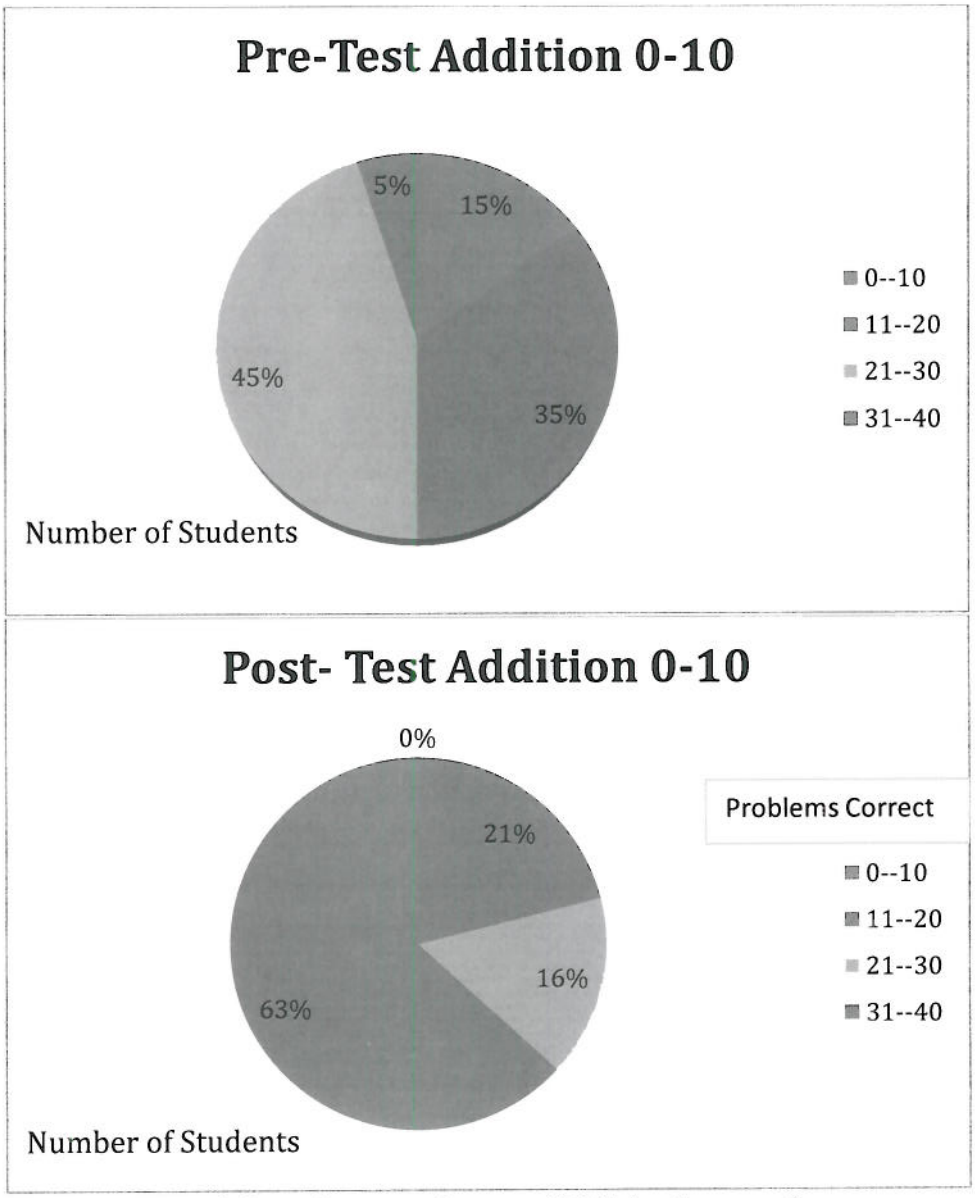

Figure 5. Growth from Pretest to Posttest (Kelly's classroom).

Addition math facts fluency is an important skill to have and continuous practice of strategies and the skill itself will lead to automaticity of addition facts. Kelly and Joan will continue to work with students on addition fact fluency and hope to continue to see more improvement and movement toward automaticity as the school year continues. We plan to use the information learned from the data to implement an action plan in order to increase addition fact fluency in our classrooms.

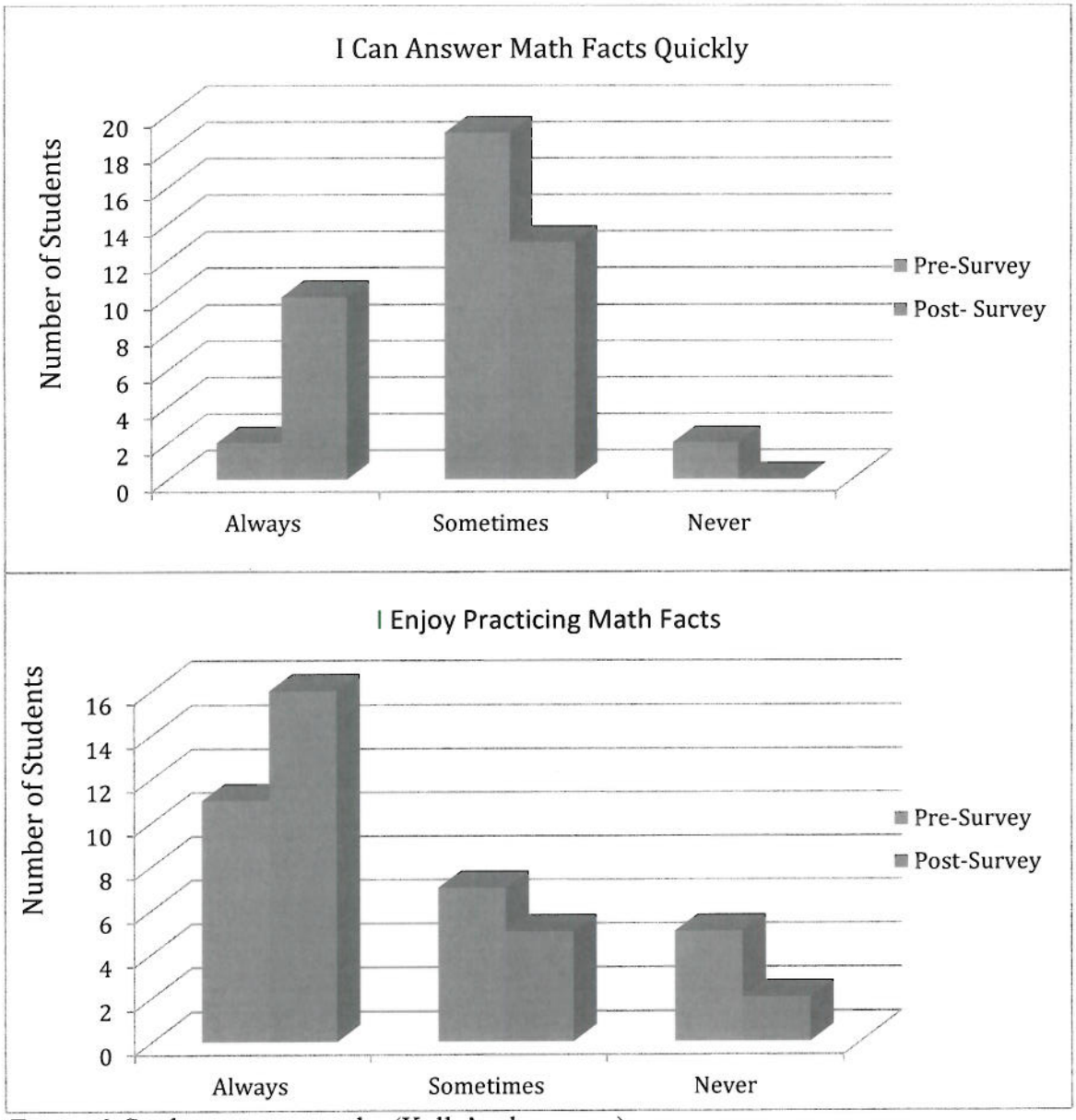

Figure 6. Student survey results (Kelly's classroom).

Action Plan

According to the data collected from the third grade students that participated in this six-week research project, improvements have been made in addition fact fluency. Overall, students have made substantial gains increasing the quantity of problems they can do in one-two minutes. Two central factors that were focused on in both classrooms were giving students automatic feedback and the time to practice. Students need that automatic feedback so that they are learning facts correctly. They also need to practice strategies to ensure they work. We were very impressed with student improvement in this short, six-week intervention.

The data that were collected has shown us that math fact instruction from previous years needs to change. We both agree that the last six weeks has been very beneficial for our students. Even though our curriculum do not allow for math fact practice, it is important for our students to be given the support to practice in the classroom. Our students need the extra support to learn and practice math facts to help them become more successful in all areas of mathematics.

Completing this study has allowed us to look at how students solve math facts and how much support they need. We feel that students should be expected to have these math facts memorized. We both agree that students need more time to help with automaticity. Some students still spend too much time using counting on strategies mentally and using fingers. We have discussed the idea of assigning nightly homework sheets as extra practice, along with what we were doing in the classroom. We felt that extra practice at home could have been beneficial to students and aide in reaching automaticity.

We also discussed if all of the elements used in our study were necessary and to what extent. We are curious to know if students would still make gains if they were not given a timed test every day. Although daily timed tests gave students the opportunity to "move up" every day, the tests did lead to student frustration for some, and more preparation for the teacher. Some students would get frustrated taking the same test every day if they were not making gains. We considered the idea of taking the timed tests 1-3 times a week so that students could have more time to review other strategies to recall the facts in between tests. If students were not given timed tests every school day, as teachers, we would not have had to prepare the test materials and grade the tests as often. However, we also had students who looked forward to taking the timed tests every day so that they could have the opportunity to improve and to "move up" to the next set of facts. We are interested in trying out a few of these variables in the future to see what will lead to more student successes.

We also discussed comparing our data with other third grade classrooms and comparing our practices with other teachers. At both of our schools, there are other third grade teachers using other practices than the elements we chose. Some teachers are simply giving students a nightly practice sheet, grading it, and then returning it to students. These students are not taking any type of timed test or receiving extra help with addition strategies. It would be interesting to see if these students would make the same gains from practicing facts and not working on strategies or taking timed tests.

We are also interested to see if students will retain their fact fluency over a long period of time. We both discussed that we want to assess our students again, later on in the year, to see what students remember and how well they would perform on the

baseline and post-assessment that was given earlier in the year. We would also like to follow up next year with the fourth grade teachers at our schools to see if students can still add single addition facts fluently or if there was any retention over the summer. We are curious if the fourth grade teachers will notice a change in student ability next year compared to the capabilities of students from previous years due to the change in the way that we taught addition.

While we were finishing up our last few weeks of this study, we both began teaching addition and subtraction with regrouping. Students were learning to add and subtract two-four digit numbers with regrouping or renaming digits. We were curious to see if students can transfer what they have learned from our fluency strategies to adding and subtracting of larger numbers. We noticed that often times students would use touch points, adding on strategies, or other manipulatives to find answers. Most of the time, students were able to find the correct answer, however, we did notice that students were still making mistakes or some would forget about the strategies learned unless reminded. We saw that automaticity was not reached, however most students were able to use a new strategy and reach an answer more quickly than what we saw in the beginning of the year. We hope that with continued practice, this skill will continue to grow.

Since this study has been completed, we felt that we saw gains in nearly all students and the time spent was well worth it for both the students and ourselves. We agreed that we would both continue to teach the strategies we focused on in this study in the future and will continue to use our timed and elapsed timed tests. We will consider experimenting with the various changes that were previously discussed to find what would best suit our students and ourselves; however, we both felt that the interventions

that were introduced were much needed. We are proud of the gains our students have made and give credit to the strategies, immediate feedback, and practice that was given to students.

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Name: _____ Date: _____

Addition Mixed Review 0s – 5s
Set 1

3 + 5 =	5 + 9 =	4 + 8 =	3 + 1 =	4 + 4 =
4 + 2 =	1 + 9 =	2 + 3 =	5 + 6 =	0 + 4 =
5 + 7 =	3 + 7 =	5 + 3 =	0 + 2 =	1 + 6 =
1 + 1 =	2 + 10 =	4 + 10 =	3 + 9 =	2 + 7 =
0 + 10 =	3 + 3 =	0 + 8 =	1 + 4 =	2 + 0 =

SCORE /25

Name: _____ Date: _____

Addition Mixed Review 6s - 10s

Set 1

6 + 8 =	9 + 5 =	8 + 4 =	8 + 9 =	9 + 10 =
10 + 10 =	6 + 3 =	7 + 9 =	6 + 5 =	8 + 3 =
7 + 5 =	7 + 3 =	9 + 6 =	10 + 7 =	6 + 1 =
6 + 9 =	10 + 2 =	10 + 4 =	9 + 3 =	7 + 2 =
10 + 1 =	7 + 7 =	8 + 0 =	9 + 0 =	8 + 6 =

SCORE _____ /25

Name _____

Score _____ / 20

Math Race #2

1 + 5	1 + 0	7 + 1	1 + 7	1 + 2
8 + 1	1 + 1	10 + 1	5 + 1	1 + 6
1 + 9	1 + 8	1 + 4	3 + 1	1 + 1
2 + 1	1 + 3	9 + 1	4 + 1	6 + 1

Appendix D

Math Fact Survey

	Always	Sometimes	Never
I can answer math facts quickly			
I study math facts at home			
I use my fingers to solve math facts			
I use pictures or tally marks to help solve math facts			
I use mental math to solve math facts			
I guess at the answer and don't really think about it.			
I enjoy practicing math facts.			